MODIS DATA STUDY

TEAM PRESENTATION

February 23, 1990

AGENDA

1. Instrument Characterization Team Requirements/Functional Definition Document Outline (Hoyt)
2. Science Data Support Team Requirements/Functional Definition Document Outline (Andrews, Ardanuy)
3. MODIS Data Packetization: An Interim Report (McKay)
4. Analyzing the MODIS Data Processing Control System's Scope (Jaffin, Ardanuy)

INSTRUMENT CHARACTERIZATION TEAM (ICT)
REQUIREMENTS/FUNCTIONAL DEFINITION DOCUMENT OUTLINE

1. INTRODUCTION

2. SOFTWARE REQUIREMENTS

- 2.1 Categories of software
  - 2.1.1 Radiometric calibration code
  - 2.1.2 Instrument performance code (thermal, mechanical, electronic aspects of instruments)
- 2.2 Pre-launch code
- 2.3 Activation period code
- 2.4 Routine operations code
  - 2.4.1 Using internal calibration sources (lamps, blackbodies, spectral calibrator)
  - 2.4.2 Using external calibration sources (ocean at 0.865 microns, space, moon, solar diffuser plate, etc.)
  - 2.4.3 Cross-calibration software (vs. HIRIS, etc.)
  - 2.4.4 Using geophysical parameter validation information
  - 2.4.5 Other instrument health issues
  - 2.4.6 Updating software and reprocessing issues
- 2.5 End-of-life period code

3. HARDWARE REQUIREMENTS

- 3.1 Direct broadcast reception hardware (at TLCF)
- 3.2 Near-real-time analyses (within or from ICC)
- 3.3 Routine analyses (MCS in TLCF)

4. COMMUNICATIONS REQUIREMENTS

- 4.1 Direct broadcast reception (if available)
- 4.2 Near-real-time
- 4.3 Routine

5. DOCUMENTATION REQUIREMENTS

- 5.1 User's guides
- 5.2 Training documents
- 5.3 Scientific papers
- 5.4 Conference proceedings
- 5.5 Instrument Characterization Reviews

6. PERSONNEL REQUIREMENTS

- 6.1 Management by team leader
- 6.2 Team member participation and review
- 6.3 Support personnel
  - 6.3.1 Research and development personnel
  - 6.3.2 Implementation personnel

7. CONCLUSIONS

SCIENCE DATA SUPPORT TEAM (SDST)
REQUIREMENTS/FUNCTIONAL DEFINITION DOCUMENT OUTLINE

1. INTRODUCTION

- 1.1 Definition
- 1.2 Scope

2. PRE-LAUNCH ACTIVITIES

- 2.1 Support Evolution of Integrated Processing System
  - 2.1.1 Review and Refine Science Requirements
  - 2.1.2 Identify and Develop Derived Requirements
    - 2.1.2.1 Utilities
    - 2.1.2.2 Near-Real-Time Processing
    - 2.1.2.3 TBD Interdisciplinary Investigation Products
    - 2.1.2.4 Browse and Metadata
  - 2.1.3 Revise and Extend Operations Concepts and Scenarios
  - 2.1.4 Track Ancillary Data Requirements and Availability
  - 2.1.5 Review and Update System Sizing Estimates
  - 2.1.6 Provide Simulated MODIS Measurements
    - 2.1.6.1 Define Earth Description
    - 2.1.6.2 Collect Geophysical Parameters Data
    - 2.1.6.3 Create Forward Model
    - 2.1.6.4 Create Orbital/Instrument Model(s)
    - 2.1.6.5 Introduce Anomalies, Noise, and Errors
    - 2.1.6.6 Take Radiance Measurements/Build Data Packets
  - 2.1.7 Coordinate Team Member/Team Leader Interactions
- 2.2 Support Algorithm Development
  - 2.2.1 Assemble Required Data Sets
  - 2.2.2 Develop Algorithms
    - 2.2.2.1 Level-1 Processing; DEM/DTM Applications
    - 2.2.2.2 Utilities
    - 2.2.2.3 Quality Assessment Techniques
    - 2.2.2.4 Near-Real-Time Processing
    - 2.2.2.5 TBD Interdisciplinary Investigation Products
  - 2.2.3 Support/Coordinate TM Algorithm Development
- 2.3 Support Software Development
  - 2.3.1 Code Level-1 Processing Software
  - 2.3.2 Code CDHF Utilities
    - 2.3.2.1 Cloud/Snow-Ice/Other Scene ID Flags
    - 2.3.2.2 I/O Routines
    - 2.3.2.3 Quality Assessment Software
    - 2.3.2.4 Level-3 Processing Software
    - 2.3.2.5 Atmospheric Corrections
    - 2.3.2.6 Browse and Metadata
  - 2.3.3 Code Team Leader Software
    - 2.3.3.1 ICT Software
    - 2.3.3.2 Scheduling Software
    - 2.3.3.3 TBD Interdisciplinary Investigation Products
  - 2.3.4 Support Development of Team Member Software
    - 2.3.4.1 Coding/Optimization of Algorithms
    - 2.3.4.2 Debugging Code
    - 2.3.4.3 Integration

2.3.4.4 Testing
2.3.5 Code Near-Real-Time Software
2.4 Support Integration and Testing
2.4.1 Develop Processing Control Software
2.4.2 Integrate Coded Algorithms
2.4.3 Support Algorithm Review and Validation
2.4.4 Support Compliance with Eos Standards
2.4.5 Manage Software and DBMS Configuration
1.1.8 Develop Near-Real-Time Software
2.5 Prepare Documents
2.5.1 Code Documentation
2.5.2 User's Guides
2.5.2 Training Guides/Manuals

3. POST-LAUNCH

3.1 Support Validation Studies
3.2 Support Field Experiments
3.3 Support Near-Real-Time Processing
3.4 Reprocessing
3.4.1 Develop Reprocessing Control Software
3.4.2 Support Reprocessing
3.5 Algorithm Changes
3.5.1 Support Algorithm Reviews/Upgrades
3.5.2 Support Cont Algorithm/Software Development
3.5.3 Implement New and Revised Algorithms
3.6 Maintain Software
3.7 Develop Special Software
3.8 Support Special Analyses

MODIS Data Packetization: An Interim Report

Alternative 1 - Single spectral band packets to facilitate selective data routing

Alternative 2 - Band-interleaved packets to minimize processing losses for products requiring multiple spectral bands

Factors that we are considering

1. Need to selectively route Level-0 data to multiple destinations

2. Potential data loss during transmission and possible impact on data products requiring concurrent data for several bands

Purpose of our analysis

Identify situations (if any) where MODIS packet structure affects factors 1) and 2) and determine impact.

Issues to be further explored

What are the data loss mechanisms for MODIS data?

Will data loss occur primarily at the CVCDU level or at the MODIS packet level?

How would loss of a CVCDU affect MODIS data packetized by alternative 1? Would alternative 2 differ?

Is data containing errors useful for MODIS processing?

Specifically, should MODIS attempt to process data uncorrectable by Reed-Solomon decoding?

What data losses and errors might occur outside the spacecraft-to-ground data link?

Analyzing The MODIS Data Processing Control System's Scope

Background

MODIS data processing will occur in a complex computer environment supporting approximately 30,000 daily processing granules for producing Levels 1-2 products. An additional quantity of daily processing granules will also become necessary. They are expected to be directed towards quick turnaround for the near real-time processing associated with on-going field experiments, reprocessing of archived MODIS datasets and radiances, and the validation of the new product algorithms submitted by MODIS science team members.

To effect the timely production of MODIS geophysical datasets and radiances as well as the successful execution of other processing tasks, the MODIS data processing system requires a control system capable of recognizing normal and error status conditions. These error conditions include missing or incomplete Eos or non-Eos datasets necessary for producing MODIS products, interruptions in executing operating or algorithm software, or hardware or device unavailability.

The data processing control system is required to recognize and respond proactively to a yet-to-be specified set of normal and adverse conditions. The data processing control system will in effect minimize the need for human intervention for recognizing and responding to processing activities. Activity and event reporting will be made on a daily or situational basis as necessary.

Accomplished to Date

To initially understand the MODIS data processing control system's requirements and context, the Upper Atmosphere Research Satellite (UARS) control system was examined. UARS is scheduled for a 1991 launch. UARS has specified a hardware architecture, the high order language, and other software tools. Its designers and developers have solved many problems that may be similar to those in the MODIS lifecycle. The UARS data processing control system responds and reacts to the events and activities shown in Table 1. Column 1 contains the MODIS entity performing each activity. UARS has combined these entities into a single entity.

Figure 1 presents an approach to a MODIS data processing control system. A simplified sketch is made of the MODIS data processing system in order to illustrate some of the conditions its control system needs to recognize for one activity--dataset production. UARS implements its control system through a combination of VAX FORTRAN-77 and INGRES. This proprietary database management system (DBMS) is used to manage tables containing scheduling and dataset status data, and comprises approximately 10 percent of the control

system's code. INGRES is representative of DBMS' implemented on a wide variety of vendor platforms, and compatible with many of the existing operating systems. Figure 2 presents the INGRES support environments, many of which are common to other DBMS' such as ORACLE.

Activities in Process

In order to present a more complete picture of the MODIS data processing control system's environment, several activities are still in process.

- Figure 1 is being expanded to more fully and specifically define the control system's environment for generating Levels 1-3 ocean data products.
- The expected amount of memory and on-line storage needed for executing the control system is being extrapolated from both MODIS requirements and UARS experience.
- The possible use of a DBMS to perform some control system tasks is being examined in terms of generic off-the-shelf product capabilities.

Completion of these three tasks in and continued refinement of MODIS requirements can support modeling possible levels of control system support. This will support designing and implementing the control system.

Table 1. Data Processing Control System Functions

MODIS Entity	UARS/UCSS Function	UCSS Implementation Methodology
	Data Transfer Services	
	Data Capture Facility (DCF) Ingest	
C	Allocate Resources for DCF Transfer	
C	Transfer Data From DCF	
C	Verify DCF Transmission	
C	Catalog DCF Transmission	
C	Report DCF Transfer Status	
C	Report DCF Communications Status	
	Remote Analysis Computer (RAC) Support	
C	Log and Verify Catalog Request (from RAC)	
C	Catalog Transferred File (from RAC)	
C	Receive RAC Data	
C	Monitor Data Requests	
	Send CDHF Data	
D	Determine Transfer Method	
D	Activate RAC Transfer Shipment Log	
D	Format CDHF Data	
D	Build Virtual File	
D	Transmit CDHF Data	
	Correlative Data Ingest	
C	Validate Correlative Format Spec.	
C	Validate Correlative Transfer Request	
C	Validate Correlative Data	
C	Catalog Correlative Data	
	Tape Generation	
D	Validate Request	
-	Identify Files for ACRIM Tape	
C	Identify Files for NSSDC Tape	
D	Identify Files for Other Tape	
D	Generate Output Tape	
D	Validate Tape and Generate Shipping Letter	

Key to MODIS Entities:

C CDHF
D DADS
I IMC

Table 1 (continued). Data Processing Control System Functions

MODIS Entity	UARS/UCSS Function	UCSS Implementation Methodology
	User Support Services	
	Interactive Support Services	
D	Copy Cataloged File	
I	Provide Catalog Query Interface	
C	Provide Interactive OS Services	
C,D	Provide Interactive OA Services	
C,D	Provide Interactive System Reporting	
	Program Interface Services	
C	Open File	
C	Read Data Records	
C	Write Data Records	
C	Close File	
C	Initialize Production Program	
C	Terminate Production Program	
C	Format Standard Printouts	
C	Provide Error Handling	
C	Provide Console Interface	
C	Provide IMSL/Math/Stat Services	
C	Checkpoint Production Program	
C	Simulate File Open on RAC	
C	Simulate Data Record Read on RAC	
C	Simulate Data Record Write on RAC	
C	Simulate File Close on RAC	
C	Simulate Prod. Control Initialization	
C	Simulate Prod. Control Termination	
C	Provide OA Services	
C	Provide Program OS Services	
	CDHF Services	
	Schedule Generation	
C	Parse Schedule Updates	
C	Validate Skeleton Syntax	
C	Delete Production Skeleton	
C	Validate List Update	
C	Select Skeletons	
C	Expand Skeletons	
C	Verify File Existence	
C	Stage Production Files	
C	Verify System Resource Availability	
C	Activate Run	
C	Close Run	
C	Parse Direct Scheduling Request	

Table 1 (continued). Data Processing Control System Functions

MODIS Entity	UARS/UCSS Function	UCSS Implementation Methodology
C	Update Production Scheduling Entry	
C	Build New Production Scheduling Entry	
	Report Generation	
C	Validate Report Specification	
C	Validate Report Request	
C	Gather Report Data	
C	Format Report	
	System Monitoring	
C,D	Monitor and Log File Storage Activity	
C,D	Monitor and Log System Status Activity	
C,D	Monitor and Log Communications Activity	
C,D	Monitor and Log Processing Activity	
C,D	Format Monitored Data for User	
C,D	Operating System Monitoring Functions	
	Data Management (Storage)	
D	Decompose Stage Request (SR)	
D	Determine Files Involved in SR	
D	Schedule SR	
D	Ensure Space Avail. for Staged Files	
D	Move File to Magnetic Tape	
D	Edit Stage Requirements	
D	Determine Next File to Destage	
D	Determine Files to Destage	
D	Destage File	
D	Edit Destage Requirements	
D	Monitor Disks/Files for Auto Destage	
	Data Management (Catalog)	
I	Provide Interactive User Catalog Func.	
I	Provide User Program Catalog Functions	
I	Provide Operations Catalog Functions	
I	Provide UCSS Catalog Functions	
I,D	DBMS	
	Recovery	
C	Log and Initiate Recovery Request	
C	Identify Files for Restart Request	
C	Verify Availability of Files for Recovery	
C	Restart Failed Program	
C	Operating System Restart Functions	

Table 1 (continued). Data Processing Control System Functions

MODIS Entity	UARS/UCSS Function	UCSS Implementation Methodology
C	Identify Files for Reschedule Request	
C	Cleanup Files for Reschedule	
C	Reschedule Failed Program	
C	Operating System Schedule Functions	
C	Monitor Recovery Processing	
	Utilities	
I	Validate Cataloged File Locations	
I,D	Back-up Data Files	
I,D	Restore Backed-up Data Files	
I,D	Copy File	
I,D	Delete File	

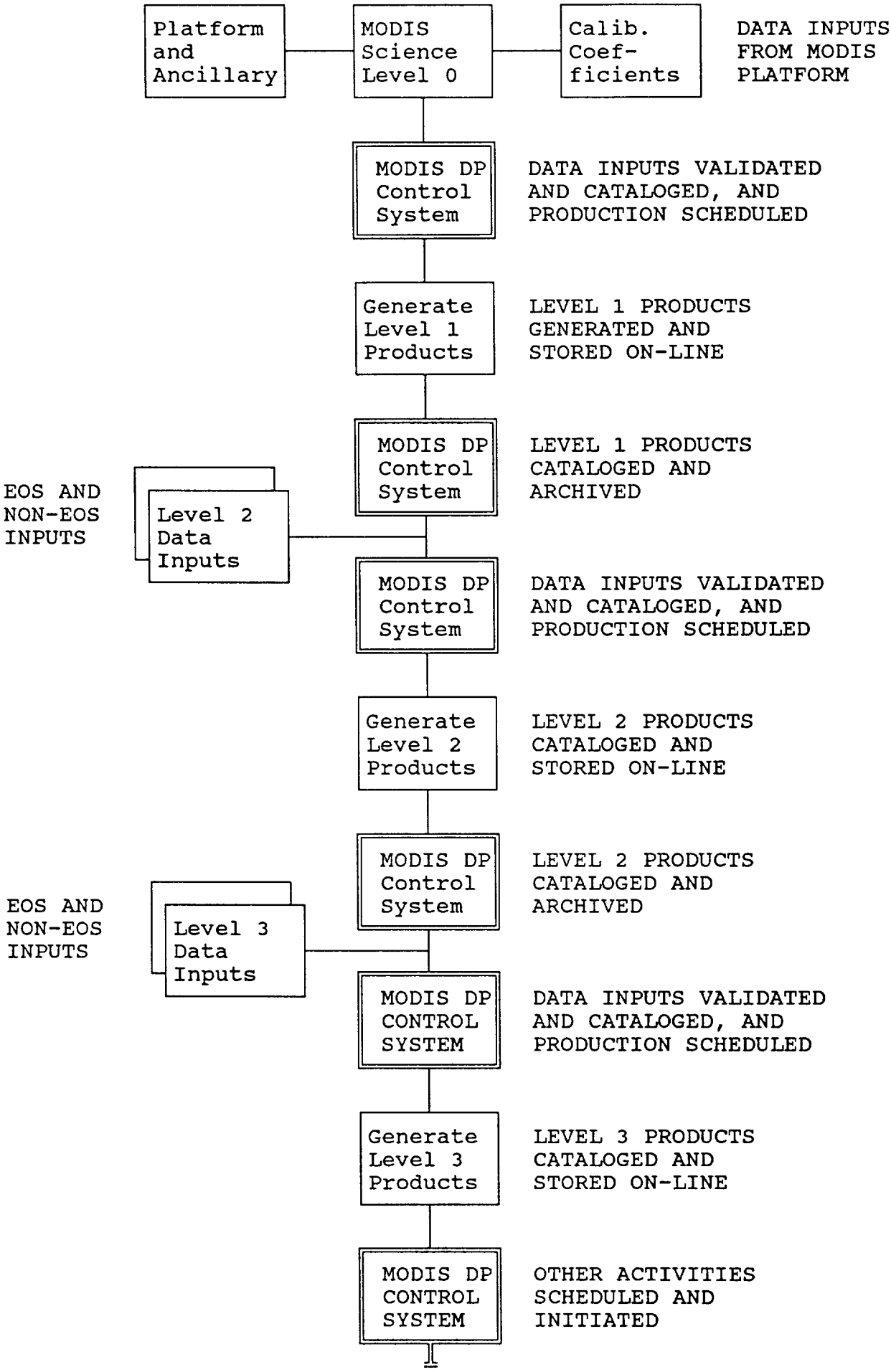

Figure 1. A Simplified MODIS DP Control System Environment

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SUPPORTED

ENVIRONMENTS

Vendor	Platform	Operating System
Amdahl	58xx	UTS
AT&T	3B15, 3B20, 3B4000, 3b/2, 6386	UNIX, System V, MS-DOS
Altos	1000, 2000	UNIX
Apple	Macintosh II	A/UX
Apollo	DN3xxx, DN4xxx, DN10000	Domain/ix
*Biin	20, 40, 60, 80	Biin/OS, BOSIX
British Telecom		UNIX
Computer Consoles	6/23	UNIX
*Concurrent	5000, 6000 family	UNIX
Compaq	386	ISC 386/ix, SCO XENIX, SCO UNIX
*Data General	MV family, Dasher PC family	AOS/VS, MS-DOS
DEC	All models	VMS, ULTRIX, 4.XBSD
*Encore	Multimax	UNIX
*Genroco	Genroco	
*Gould	PN	UTX
Hewlett-Packard	9000/300, 9000/800, 3000/900, Vectra	HP-UX, MPE XL, MS-DOS, SCO UNIX
*IBM	370, PC/AT, PS/2, RT	MS-DOS, AIX/RT, PS/2 AIX, AIX/370
*ICL	Clan series	
*Intergraph	Clipper	UNIX
*MIPS	M/120, M/1000, M/2000 system	UNIX
*Matra		UNIX
*Motorola	Delta 3000	UNIX
NCR	Tower 32 Series	UNIX
NeXT	NeXT Computer	Mach
*Nokia Data		
Prime	EXL	UNIX
Pyramid	98xx, 90xx, MIServer	OSX
SCO	Open Desktop	SCO UNIX
Sequent	Symmetry	Dynix
*Siemens		
Solbourne	Solbourne	SunOS
Sun Microsystems	3, 4, 386i, SPARCsystem	SunOS
Tandem	S2	UNIX
*Tektronix	4300 series	UNIX
Unisys	5000, 6000, 7000 series	UNIX

*Sold and supported exclusively by OEM vendor

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Figure 2.